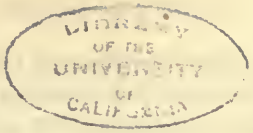

Issued April 10, 1913.

United States Department of Agriculture,

BUREAU OF SOILS—CIRCULAR No. 76.

MILTON WHITNEY, *Chief of Bureau.*

U. S. DEPARTMENT OF AGRICULTURE,
Washington, D. C., January 25, 1913.

SIR: I have the honor to transmit herewith the manuscript of a report covering investigations of alunite and kelp as potash fertilizers, by J. J. Skinner and A. M. Jackson, of this bureau, and to recommend that this article be published as Circular No. 76 of the Bureau of Soils.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

ALUNITE AND KELP AS POTASH FERTILIZERS.

By J. J. SKINNER and A. M. JACKSON,
Scientists in Soil Fertility Investigations.

The investigations by this bureau of the fertilizer resources of the United States has led to suggestions from time to time of the use of certain minerals and of kelp as potash fertilizers. The use of these substances as sources of potash salts is described in other publications. In this paper are given the results of several experiments showing the effect of the mineral alunite and of kelp on soils.

Alunite has been described in a circular by Waggaman [1] as a double sulphate of potassium and aluminum which, on heating, first gives off water and sulphur trioxide, leaving a residue consisting largely of potash alum, and on further heating at a higher temperature decomposes with an evolution of the oxides of sulphur, leaving the final residue composed chiefly of potassium sulphate and alumina. Waggaman suggested that it might be more practicable from an economic standpoint to use ignited alunite directly as a fertilizer than to leach the potassium sulphate from the residue. He found that a large amount of water is required to free entirely the ignited residue from soluble salts and that the subsequent evaporation is tedious and expensive.

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[1] Alunite as a source of potash. Cir. No. 70, Bureau of Soils, U. S. Dept. Agr. (1912).

In the experiments made to test the effect of this mineral on the soil both the raw and the ignited alunite were used. The sample of raw alunite, containing 10 per cent of potash (K_2O), was finely ground. The ignited alunite was also thoroughly pulverized. It contained 14.7 per cent K_2O. These minerals were applied to soil in such quantities as to add 25, 50, 100, 200, and 500 pounds of potash (K_2O) per acre. Equivalent amounts of potash as potassium sulphate and potassium chloride, the soluble potash salts, were included in the experiment in order to compare the efficiency of the potash-carrying mineral, alunite, with the pure soluble potash salts.

Cameron and his associates are making a thorough investigation of the kelps of the Pacific coast and conclude that they are at present the most promising source of potash in the United States.[1] That kelps have value as a fertilizer has long been known. Seaweed has been used locally as a fertilizer on the Pacific coast, in New England, and in European countries. It is stated that the giant kelps of the Pacific coast, namely, *Nereocystis luetkeana* and *Macrocystis pyrifera*, are essentially different from the Atlantic kelps and those of Japan in that the potash content is higher and the iodine content lower. The dry kelps from the Pacific coast contain 30 per cent or more potassium chloride as an average of a large number of samples.

The effect of the kelp on soil was tested. The kelp used was dry and powdered. It contained 19.8 per cent of potash (K_2O). It was applied to soil in amounts sufficient to add 25, 50, 100, 200, and 500 pounds of potash (K_2O) per acre. This experiment was carried on at the same time as the experiments with alunite, and the fertilizing action of the two substances was compared with potassium sulphate and potassium chloride.

CULTURAL METHOD.

The effect of these potash fertilizers in soils was tested by growing wheat plants in the treated soil in paraffined wire pots. The wire-pot method for testing the efficiency of fertilizers and the fertilizer requirement of soils is described fully in Circular No. 18 of this bureau. The soil was weighed into pans, 3 pounds to each pan. The soil in one pan received no fertilizer and was used as a control. To each of the other pans the fertilizer to be tested was added. To the different pans of soil were added raw alunite, ignited alunite, kelp, potassium sulphate, and potassium chloride, each in quantities of 25, 50, 100, 200, and 500 pounds of K_2O per acre, based on an acre half-foot of soil weighing 2,000,000 pounds.

[1] Cameron, Frank K., and others: Fertilizer Resources of the United States. S. Doc. No. 190, 62d Cong., 2d sess., 1912. Further investigations are now in progress.

The soil used in the first experiment was the Carrington loam—a soil which is known to respond well to potash fertilizers in field practice. The soil was treated with the various fertilizers in pans on October 22, was well mixed by sifting, and was potted October 28. Three pots, each holding about a pound of soil, were used for each treatment. Six wheat plants were planted in each pot. The plants grew until November 29. At the end of the experiment the plants were cut and the green weights recorded. The results of the test are given in Table I. The last column gives the relative growth of the different treatments. The growth of the check or control is taken as 100. The third column gives the green weights of the three cultures in each treatment.

TABLE I.—*Effect of alunite and kelp on growth as compared with potassium sulphate and potassium chloride.*

Treatment.	Quantity of K_2O added per acre.	Green weight.	Relative growth.	
	Pounds.	*Grams.*	*Per cent.*	
Soil untreated		3.35	100	
Soil + raw alunite	25	3.70	110	114
	50	4.00	119	
	100	4.02	120	
	200	3.77	112	
	500	3.72	111	
Soil + ignited alunite	25	4.58	136	140
	50	4.77	142	
	100	4.80	143	
	200	4.80	143	
	500	4.53	135	
Soil + kelp	25	3.93	117	131
	50	4.67	139	
	100	4.80	143	
	200	4.40	131	
	500	4.30	128	
Soil + K_2SO_4	25	4.27	127	138
	50	4.33	129	
	100	5.12	152	
	200	4.52	135	
	500	4.90	146	
Soil + KCl	25	4.40	131	131
	50	4.33	129	
	100	4.50	134	
	200	4.37	130	
	500	4.40	131	

By examination of the table it is seen that each of the potash fertilizers produced an increased growth over the untreated soil. The raw alunite used in amounts of 25 to 500 pounds of K_2O per acre increased growth from 10 to 20 per cent. The best results were secured with 50 to 100 pounds of potash (K_2O) per acre. The average increase over the untreated soil of the five amounts was 14 per cent. When the growth is compared with that produced by the ignited alunite it is seen that this caused larger growth with each amount used than did the raw alunite. The increase in growth with

ignited alunite over the untreated soil varied from 35 to 43 per cent, the average increase being 40 per cent. The growth with the raw alunite was not as good as with similar amounts of potash as potassium sulphate and potassium chloride. The average increase with potassium sulphate was 38 per cent and with potassium chloride was 31 per cent. The effect of ingited alunite was about the same as that of potassium sulphate, and greater than that of the potassium chloride.

Kelp produced a considerable increase in growth over the untreated soil. The increase varied with the different amounts, from 17 to 43 per cent. The average increase over the untreated soil was 31 per cent. The increased growth was about the same as that produced by potassium chloride, and was slightly less than that resulting from the use of potassium sulphate. It should be here noted that the potash in the kelp is in the form of the chloride.

Another experiment was made to test the effect of these potash compounds, using this time a different soil. Otherwise the details of the experiment were the same as in the first test. The soil used in this test was the Volusia silt loam. The plants grew from November 19 to December 21. Three pots were used for each treatment. The results are given in Table II.

TABLE II.—*Effect of alunite and kelp on growth, as compared with potassium sulphate and potassium chloride.*

Treatment.	Quantity of K_2O added per acre.	Green weight.	Relative growth.	
	Pounds.	*Grams.*	*Per cent.*	
Soil untreated		2.84	100	
Soil + raw alunite	25	3.35	118	
	50	3.40	120	
	100	3.36	118	116
	200	3.36	118	
	500	3.02	106	
Soil + ignited alunite	25	3.54	124	
	50	3.70	130	
	100	3.70	130	131
	200	3.90	137	
	500	3.94	136	
Soil + kelp	25	3.24	114	
	50	3.54	124	
	100	3.59	127	123
	200	3.60	127	
	500	3.45	121	
Soil + K_2SO_4	25	3.08	108	
	50	3.62	127	
	100	3.87	136	125
	200	3.68	129	
	500	3.54	124	
Soil + KCl	25	3.04	108	
	50	3.50	123	
	100	3.50	123	122
	200	3.74	131	
	500	3.60	127	

Each of these potash fertilizers had a beneficial effect on Volusia silt loam. The raw alunite again produced less increased growth than the ignited alunite. This was true with each amount of the substances used. The raw alunite was not as effective as potassium sulphate and potassium chloride. However, the ignited alunite was more effective. The average increase for the raw alunite was 16 per cent, for the ignited alunite 31 per cent, for potassium sulphate 25 per cent, and for potassium chloride 22 per cent.

As in the first experiment kelp again produced considerable increase in growth. The effectiveness in producing plant growth was practically the same as that of potassium sulphate and potassium chloride. Kelp gave as an average 23 per cent increase in growth, potassium sulphate 25 per cent, and potassium chloride 22 per cent increase. In addition to the amount of potash added to the soil by the kelp, it contains a small amount of nitrogen and phosphorus, which should be effective in the soil. From these two experiments it seems that the dried kelp and ignited alunite are about as effective potash fertilizers as the salts, potassium sulphate and potassium chloride.

Approved:

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *January 30, 1913.*

[Cir. 76]

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1913